Mortality in eggs of pear psylla (Homoptera: Psyllidae) caused by fenoxycarb in combination with a water drench

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ABSTRACT

Applications of the insect growth regulator fenoxycarb in pear before the appearance of foliage kills the eggs of pear psylla, *Cacopsylla pyricola* (Foerster), laid on newly expanded foliage 4 weeks after the application. We hypothesized that water in the form of rainfall or overhead irrigation transports the product from sprayed wood onto new foliage in sufficient amounts that eggs on foliage are killed. We tested this hypothesis by covering fenoxycarb-sprayed limbs with waterproof plastic, removing the covers 4 weeks later, immediately drenching half of the limbs with water, and then comparing egg hatch on drenched and non-drenched limbs. We also monitored egg hatch on uncovered limbs. Egg mortality 4 weeks after the application was two-fold higher on limbs drenched with water than on covered, non-drenched limbs (52% vs 26%). Mortality on limbs without fenoxycarb was less than 10%. Eggs deposited on fenoxycarb-treated but uncovered limbs also showed high rates of mortality (33-44%), which may have been due to rainfall in mid-April transporting fenoxycarb onto foliage.

Key words: pear psylla, insect growth regulators, Yakima Washington

INTRODUCTION

The insect growth regulator fenoxycarb is effective against pear psylla, *Cacopsylla pyricola* (Foerster), an important pest of pears in the Pacific Northwest and parts of Europe (Solomon and Fitzgerald 1987, McMullen 1990, Higbee *et al.* 1995). Currently, it is being used against psylla (under the trade name 'Comply') during the prebloom period. Horton (1996) showed that an application of fenoxycarb at the delayed dormant stage in pear (bud scales just beginning to spread) reduced the hatch of eggs deposited on newly expanded foliage 4 weeks after the spray. Egg mortality was about 40% on sprayed trees compared to less than 5% on unsprayed trees (Horton 1996). Laboratory studies show that even highly dilute solutions of fenoxycarb cause extensive egg mortality in psylla (McMullen 1990), and one possible explanation for the egg-kill on unsprayed foliage is that fenoxycarb is transported from sprayed wood to foliage by rainfall or overhead irrigation. In this study, we looked at the effects of water on egg-kill by covering fenoxycarb-sprayed limbs with water-proof covers, and determining egg mortality on covered and uncovered foliage either with or without a water drench.

MATERIALS AND METHODS

Experiments were conducted at an experimental orchard near Yakima, WA, in spring 1996 and 1997. Five treatments were compared: (1) control (no fenoxycarb, limb left uncovered); (2) fenoxycarb (limb left uncovered); (3) control (no fenoxycarb, limb covered); (4) fenoxycarb (limb covered); (5) fenoxycarb (limb covered, cover removed after 4 weeks and limb drenched with water). Fenoxycarb (0.15 g [AI] per liter of water) was applied with a handsprayer at the delayed

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dormant stage (19 Mar 1996; 21 Mar 1997). Control limbs were sprayed with water. In both years, 5 limbs per treatment (each at mid-canopy level) were randomly selected from approximately 20 trees. Treatments were then randomized among limbs. For the most part, limbs were on different trees; however, a few trees in both years had two limbs selected, in which case they were chosen from opposite sides of the tree. Each limb was 0.75-1.0 m in length. Limbs were sprayed just to the point of drip (50-100 ml of fenoxycarb or water per limb). For the uncovered controls (treatment (1)), 10 and 15 fruiting clusters were randomly selected from approximately 10 unsprayed trees in 1996 and 1997, respectively.

Treated and control limbs that were to be protected had an inverted, bowl-shaped cover (50 l in volume) constructed of 10 mil Mylar plastic. The cover was placed so that the limb was completely protected from precipitation. Holes were punched along the bottom edge of each cover, and twine was used to tie the bottom of the cover to the limb. Irrigation was delayed both years until after the study.

The water drench was applied by removing the cover 4 weeks after the spray (20 April 1996; 21 April 1997) and then drenching the limb with water using a handsprayer (water applied until runoff). Limbs were cut from the trees immediately after the drench and taken to the laboratory to monitor egg hatch. Limbs from the other 4 treatments were also collected at this time. Control samples were drenched with water before removing them from the trees.

To monitor egg hatch, 3-10 bloom clusters (depending upon egg densities) were taken from each limb. The clipped end of each cluster was put in water to keep the foliage turgid. Several egg-laden leaves on each cluster were marked with a small spot of typewriter correction fluid, and the eggs were counted. Clusters were then kept at 23° C to allow the eggs to hatch. After 8-10 days, unhatched eggs were counted. The 3-10 flower clusters from each limb were assumed to be a single sample, and the data were pooled from clusters on one limb. Therefore, sample sizes were 10 limbs for each treatment (5 limbs in 1996 + 5 limbs in 1997) except for the uncovered control, in which $n = 25$ (10 clusters in 1996 + 15 clusters in 1997).

Effects of treatment on the percentage of eggs failing to hatch were estimated with a two-way (year x treatment) analysis of variance (ANOVA). Percentages were arcsin transformed before analysis. Non-transformed means are given. Specific treatment comparisons were extracted with pre-planned single df contrasts.

RESULTS

There were large differences among treatments in percentage of eggs failing to hatch in both years (Fig. 1). Patterns were similar between years, as indicated by nonsignificant year and year x treatment effects (Table 1). Egg mortality was very high in several of the fenoxycarb treatments, reaching 50% in the water drench treatment and 33-44% on limbs that were sprayed but left uncovered (Fig. 1). The increase in egg mortality caused by fenoxycarb was highly significant (Table 1; contrast (1)). Egg mortality was two-fold higher on fenoxycarb-sprayed branches that were drenched with water than on limbs that were covered but not drenched (Fig. 1; Table 1: contrast (2); mean [averaged over years] percentage kill = 52.9% [limb covered; drenched] and 26.3% [limb covered; no drench]). Contrast (3) tests whether egg mortality on fenoxycarb-treated limbs differed between uncovered limbs (i.e., those exposed to rainfall) and covered limbs in the absence of a water drench. There is a marginally significant indication (Table 1: contrast (3) [$p = 0.076$]) that egg mortality was higher on the uncovered limbs (mean [averaged over years] percentage egg kill = 38.7%) than on the non-drenched, covered limbs (mean percentage egg kill = 26.3%).

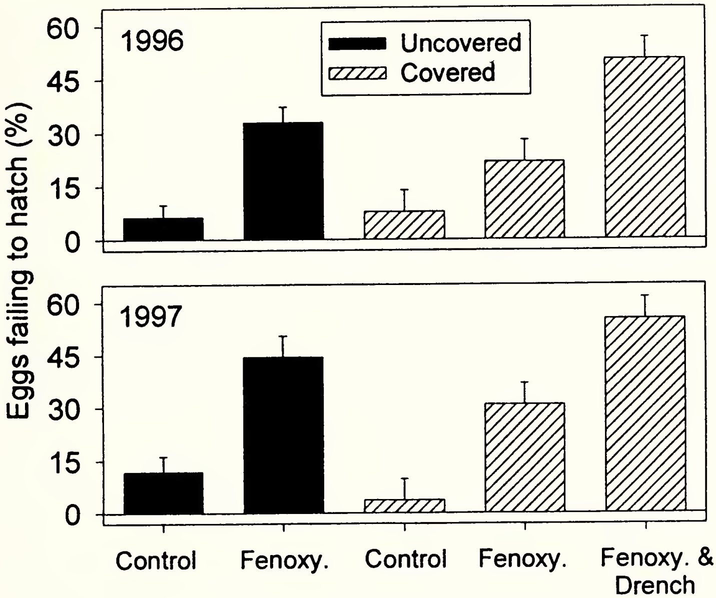

Figure 1. Mean (±SE) percentage egg mortality on control (no fenoxycarb) and fenoxycarb-treated limbs. Black bars: no plastic covers; cross-hatched bars: limbs with plastic covers. See Table 1 for results of ANOVA. $n = 5$ replicates per bar, except for uncovered controls in which $n = 10$ (1996) and 15 (1997).

Table 1.

Analysis of variance and contrasts summarizing the effects of fenoxycarb and water drench on hatch of eggs deposited by pear psylla (means summarized in Figure 1). Data arcsin transformed for analysis.

Source	df	MS	F	$p > F$
Year	1	0.060	1.86	0.18
Treatment	4	0.807	25.23	<0.001
Year x Treatment	4	0.017	0.52	0.72
Error	55	0.032		
Contrasts:				
(1) Control versus fenoxycarb[1]	1	2.69	84.06	<0.001
(2) Covered limb: fenoxycarb versus fenoxycarb + drench[2]	1	0.43	13.34	<0.001
(3) Fenoxycarb: covered limb (no drench) versus uncovered limb[3]	1	0.10	3.27	0.076

[1] Contrast compares the mean of the two control treatments (7.4% mortality) to the mean of the three fenoxycarb treatments (39.2%) (averaged over year).
[2] Contrast compares middle cross-hatched bar to cross-hatched bar on right (Figure 1; averaged over year).
[3] Contrast compares black bar on right to middle cross-hatched bar (Figure 1; averaged over year).

DISCUSSION

By applying fenoxycarb at the delayed dormant stage and then again 4 weeks later, growers obtain good control of prebloom psylla populations (Hilton and Westigard 1994; Horton 1996).

However, the double application is very expensive, and many growers generally eliminate either the first or second spray; questions remain about the best timing for a single application (Hilton and Westigard 1994; Horton 1996). Horton (1996 and unpublished; see also Hilton and Westigard 1994) suggested that a single delayed dormant application, at least in certain years, provides a level of control similar to that of two applications. One factor contributing to the effectiveness of the delayed dormant spray must be the high rates of egg mortality that occur well into April (Fig. 1; and Horton 1996), despite the fact that these late-spring eggs are deposited almost exclusively on unsprayed foliage.

Rates of egg mortality were two-fold higher on covered, drenched limbs than on covered, non-drenched limbs (Fig. 1). The most logical explanation for this observation is that water transported fenoxycarb from sprayed wood onto unsprayed foliage; residue analysis would be necessary to confirm this explanation. There was a weak (p = 0.076) suggestion in the fenoxycarb treatments that egg mortality was higher on uncovered limbs than on non-drenched covered limbs (Table 1: contrast (3)), which may indicate that precipitation also transports the fenoxycarb. Overhead irrigation could not have been responsible for the egg mortality on the uncovered limbs, because the first irrigation in both years occurred after completion of the study. Both years had intervals of measurable rainfall between 10 April and the day that limbs were removed, including 0.36 cm of rain that fell the day before limb removal in 1997 (from National Climatic Data Center publications for city of Yakima).

Some of the egg mortality in the fenoxycarb treatments cannot be attributed to the action of water, because eggs that were deposited on covered limbs also showed increased levels of mortality even in the absence of a water drench (Fig. 1: compare middle cross-hatched bar to controls). Eggs laid on unsprayed surfaces by females that previously contacted fenoxycarb-treated surfaces have lower hatch rates (Higbee *et al.* 1995), and this might explain the 20-30% rates of egg mortality that occurred on the covered, non-drenched limbs.

In summary, our results reconfirm the observation that a single application of fenoxycarb before spread of bud scales causes mortality in eggs of pear psylla well into April (see Horton 1996). Results of the drenching experiment suggest that growers who rely on a single spray to manage psylla may improve control by judicious use of overhead irrigation. Furthermore, a single spray might prove to be less effective in a very dry spring than in a wetter spring, which may explain some of the variation among years in control that the senior author has noted.

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